Neurorobotics

The nervous system is a vital part of organisms to survive and it endows them with remarkable abilities, such as perception, recognition, regulation, learning, and decision-making, by intertwining myriad neurons. To realize such outstanding efficacies and functions, many artificial devices and systems have been investigated to emulate the operating principles of the nervous system. An artificial reflex arc (ARA) and artificial pain modulation system (APMS) are proposed to imitate the unconscious behaviors of the spinal cord. Gdx Oy - and Alx Oy -based charge-regulated field-effect transistors (CRFETs) with a monolayer graphene channel were fabricated and adopted as inhibitory and excitatory synapses, respectively, under the same pulse signals to mimic the biological reflex arc through a connection with a poly(vinylidene fluoride-co-trifluoroethylene)-based actuator. Additionally, a memristor was integrated with a CRFET as the interneuron to regulate the Dirac point by controlling the voltage drop on the graphene channel, analogous to the descending pain pathway in the spinal cord, to prevent excessive pain perception. The proposed ARA and APMS have provided a significant step forward to realizing the functions of the nervous system, giving promising potential for developing future intelligent alarm systems, neuroprosthetics, and neurorobotics [1].

1)
Fu Y, Chan YT, Jiang YP, Chang KH, Wu HC, Lai CS, Wang JC. Polarity-Differentiated Dielectric Materials in Monolayer Graphene Charge-Regulated Field-Effect Transistors for an Artificial Reflex Arc and Pain Modulation System of the Spinal Cord. Adv Mater. 2022 May 26:e2202059. doi: 10.1002/adma.202202059. Epub ahead of print. PMID: 35619163.